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AODV AND DSR MANET ROUTING PROTOCOLS: A COMPARISON OF PERFORMANCE

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ABSTRACT

A Mobile Ad hoc NET work (MANET) is a self-configuring network formed by independent nodes connected to each other through wireless links. Of late, MANETs have been a vital area of interest for investigation and research due to the boom in the communication industry. An important issue related to the MANETs is their routing protocols. A number of routing protocols are in use and one of the critical factors for the comparison amongst these protocols is their performance. In this paper, authors have made an attempt to compare the performance of two of the most famous routing protocols in MANETs: Ad hoc On demand Distance Vector (AODV) routing and Dynamic Source Routing (DSR) protocols. For this purpose, the performance of both these routing protocols has been compared through simulation using Network Simulator using the parameters: number of packets delivered, communication time and Time-To-Live (TTL) of a packet. It has been established that performance of AODV based on these parameters is better than that of DSR.

KEYWORDS: AODV, DSR, Mobile Ad hoc Network, Network Simulator, Protocol, Time-To-Live

INTRODUCTION

Wireless Network is a network without the connecting cables [1][2] and is generally implemented and administered using a transmission media called radio waves. It can be classified into two types: Infrastructure or Infrastructure less. A mobile ad-hoc network is a collection of wireless mobile hosts forming a temporary network without the aid of any stand-alone infrastructure or centralized administration [3]. The history of wireless networks can be traced to 1970s and the interest has been growing ever since. With wired networks, this sharing of information is difficult, as the users need to perform administrative tasks and set up static, bidirectional links between the computers. This motivated the construction of temporary networks with no wires, no communication infrastructure and no administrative intervention required. Such interconnection between mobile computers is called an *Ad hoc Network* [4].

Mobile Ad hoc NET works (MANETs) represent complex distributed systems comprising of wireless mobile nodes that can freely and dynamically self-organize into arbitrary and temporary, ''ad-hoc'' network topologies, allowing people and devices to seamlessly internetwork in areas with no pre-existing communication infrastructure, e.g., disaster recovery environments [5]. A MANET is an autonomous ad hoc wireless networking system with dynamically changing network connectivity. No static or fixed infrastructure exists in MANETs and no centralized control is available. The network can be formed anywhere, at anytime, as long as two or more nodes are connected which communicate with one another either directly when they are in radio range of each other or via intermediate mobile nodes because of flexibility that a MANET offers. The real world applications of MANETs are Military Communications and operations, automated battlefields, sensor networks, emergency services, commercial environments, home and enterprise networking,

educational applications, entertainment, location-aware services, disaster relief services, etc [6]. The vital characteristics of MANETs are: a) Autonomous and infrastructure less, b) Multi hop routing, c) Dynamic Network topology, d) Variation on link node capabilities, e) Energy constrained operation, and f) Network scalability [7].

ROUTING AND PROTOCOLS

Routing is the process of selecting paths in a network along which the network traffic is routed. Routing is a key feature of the Internet because it enables messages to pass from one computer to another and eventually to reach the target machine. Each intermediary computer performs routing by passing along the message to the next computer. Part of this process involves analyzing a *routing table* to determine the best path [8]. Various routing protocols are used in order to transfer data from source to destination both in wired and wireless networks.

The responsibilities [9] of a routing protocol include exchanging the route information; finding a feasible path to a destination based on criteria such as hop length, minimum power required, and lifetime of the wireless link; gathering information about the path breaks; mending the broken paths expending minimum processing power and bandwidth; and utilizing minimum bandwidth.

- **Issues in Designing a Routing Protocol for MANETs**

Routing in MANETs is a difficult task because the network topology keeps on changing due to the mobility of nodes. The various issues in designing a routing protocol are as under [9]:

Mobility

Bandwidth Constraint

Hidden and exposed terminal problems

Error-Prone Shared Broadcast Radio Channel

Resource Constraints

CLASSIFICATION OF MANET ROUTING PROTOCOLS

The MANET Routing Protocols have been mainly classified into three types: (a) Table-driven or proactive, (b) On-demand driven or reactive and (c) Hybrid protocols. There is a broad classification of MANET routing protocols as in [9], but in this paper we present the mostly used important protocols as mentioned in Figure 1. Two of the most important protocols that are Ad hoc On-demand Distance-Vector (AODV) and Dynamic Source Routing (DSR) are taken up for comparison and rest of the protocols are left as a subject of experimentation in near future.

- **Table-Driven or Proactive Protocols**

In table-driven or Proactive routing protocols, network topology information is maintained by every node, in the form of routing tables that are exchanged from time to time. Routing information is generally flooded in the whole network. A path finding algorithm is run whenever a node requires a path to a destination. It contains protocols such as Destination Sequenced Distance Vector (DSDV), Wireless Routing Protocol (WRP), Cluster-head Gateway Switch Routing protocol (CGSR), Source-Tree Adaptive Routing protocol (STAR), etc.

- **On-Demand Driven or Reactive Protocols**

Reactive or On-Demand routing protocols do not maintain any kind of topology information tables. They establish a particular path to the destination whenever it is demanded by using a proper connection establishment technique. It contains protocols such as Dynamic source routing (DSR), Ad hoc On-demand Distance Vector (AODV), Temporally Ordered Routing Algorithm (TORA), Associatively Based Routing (ABR), etc.
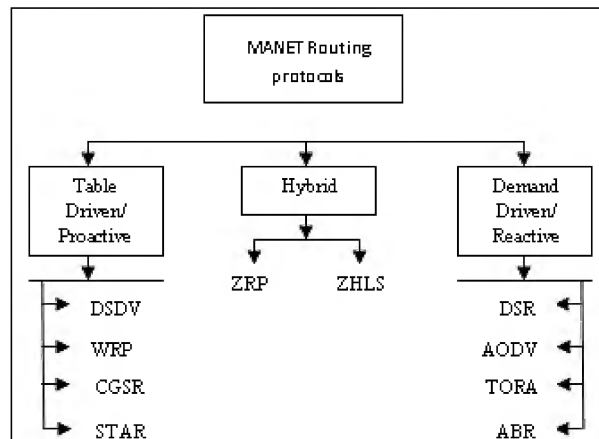

Figure 1: Classification of MANET Routing Protocols

- **Hybrid Protocols**

Hybrid routing protocols contain the features of both the Proactive and Reactive routing protocols. For the nodes nearby or in the same geographical region Proactive protocols are used and for the nodes far away reactive routing protocols are used. Various hybrid protocols are Zone Routing Protocol (ZRP), Zone-based Hierarchical Link State routing protocol (ZHLS), etc.

AD HOC ON DEMAND DISTANCE VECTOR ROUTING PROTOCOL

Our particular on-demand protocol, the AODV routing protocol, was first proposed in an Internet Engineering Task Force (IETF) Internet draft in fall of 1997. Since that first version, AODV has evolved into a carefully specified ad hoc network routing protocol that provides path discovery and maintenance in a wide variety of network topologies and environments [10]. AODV is a 'reactive routing protocol' with small delay. In AODV every hop has the constant cost of '1'. The mechanism of protocol is as follows: the route request packet is flooded in the network. The packet contains its IP address, current sequence number, destination's IP address, destination's last sequence number and broadcast ID. The nodes receiving this packet if being destination node, send back the route reply packet; else rebroadcast the packet to other nodes. All the nodes keep track of the packet's source IP address and broadcast ID. If the same packet is received again it is discarded.

- **Benefits and Limitations**

The main advantages of this protocol are:

- o Link breakages can be handled and repaired.

- o Routes are established at the time of transfer and destination sequenced numbers are used to find the latest routes to the destination. Because of this the connection set up delay is less

Other benefits of AODV as stated in [11] are:

- It favors the least congested route instead of the shortest route and it also supports both unicast and multicast packet transmissions even for nodes in constant movement.

- It also responds very quickly to the topological changes that affects the active routes.

- It does not put any additional overheads on data packets as it does not make use of source routing.

  The limitations of AODV as stated in [11] are:

- The multiple Route Reply packets in response to a single Route Request packet can lead to heavy control overhead.

- The various performance metrics begin decreasing as the network size grows.

- It is vulnerable to various kinds of attacks as it based on the assumption that all nodes must cooperate and without their cooperation no route can be established.

- **Another Limitation is:** Intermediate nodes can lead to inconsistent route if the source sequence number is very old and the intermediate nodes have a higher but not the latest destination sequence number, thereby having stale entries.

DYNAMIC SOURCE ROUTING PROTOCOL

Dynamic source routing protocol is the demand driven protocol that is based on a method known as source routing that is the sender is aware of the complete hop-by-hop route to the destination. The use of source routing [12] allows packet routing to be trivially loop-free, avoids the need for up-to-date routing information in the intermediate nodes through which packets are forwarded, and allows nodes forwarding or overhearing packets to cache the routing information in them for their own future use. These routes are stored in route cache. This protocol contains two phases: Route Discovery and Route Maintenance. Whenever a mobile node sends a packet to another node it first checks for the route in its route cache.

If it has an unexpired route then it uses that route to send the packet and if its not there then it first discovers the route to destination by broadcasting a *route request* packet. Each node that receives the packet rebroadcasts the packet if its not the destination node or it has in its route cache an unexpired path to the destination path else it replies back with a *route reply*. Meanwhile, the packet contains a *route record* that maintains the sequence number of the hops taken to the destination node or intermediate node. The path traversed by the route reply packet is recorded for future use of path. And if any link to the destination is broken then a *route error* packet is generated and the new route discovery process starts all over again.

- **Benefits and Limitations**

  o As a reactive approach is used so there is no need to periodically send update messages within the network.

  o Another advantage is that there is no need to find routes to all nodes in the network. Only the route that is required at the time of the transfer is identified and the unnecessary wastage of bandwidth is avoided.

The benefits of DSR as stated in [11] are:

- Route caching can further reduce route discovery overhead. A single route discovery may yield many routes to the destination, due to intermediate nodes replying from local caches.

- The DSR protocol guarantees loop-free routing and very rapid recovery when routes in the network change.

- In addition, DSR has been designed to compute correct routes in the presence of asymmetric (uni-directional) links.

- But the disadvantage of this approach is that it does not have proper mechanism to repair the broken links.

The limitations as stated in [11] are:

- The DSR protocol is mainly efficient for mobile ad hoc networks with less than two hundred nodes; this is not scalable to large networks.

- DSR requires significantly more processing resources than most other protocols.

- Packet header size grows with route length due to source routing.

- Flood of route requests may potentially reach all nodes in the network.

SIMULATION ENVIRONMENT

We have simulated the above mentioned two protocols using an efficient simulation tool Network Simulator (Version 2.34). Ns [13] is a discrete event simulator targeted at networking research. Ns provides substantial support for simulation of TCP, routing, and multicast protocols over wired and wireless (local and satellite) networks. It began as a variant of the REAL network simulator in 1989 and has evolved substantially over the past few years. In 1995 Ns development was supported by DARPA through the VINT project at LBL, Xerox PARC, UCB, and USC/ISI. Currently its development is supported through DARPA with SAMAN and through NSF with CONSER, both in collaboration with other researchers including ACIRI [13].

Our main objective of simulation is the comparison of performance of both the protocols. In order to evaluate the performance of these two protocols, the performance metric used is *Simulation time versus packet delivery.* Also the *time to live* constraint of the packet has also been considered. Simulation time is taken as a performance metric because it is representing the actual time of communication within all nodes. In the graphs that follow, it is expressed along the X-axis and the number of packets is expressed along Y-axis. Table 1 gives the values of all the parameters used by us for simulation of the network traffic imitating the working of a MANET.

Table 1: Simulation Parameters

Parameter	Value
Number of Nodes	06
Topography dimension	800 X 800
Traffic Type	CBR
Radio Propagation Model	Two-Ray Ground Model
MAC Type	802.11_MAC layer
Mobility Model	Random way point
Antenna Type	Omni directional

All the simulations were executed using a network of 6 nodes. An optimum value of nodes is taken to conduct the tests for small scale networks. Nodes are randomly placed in an area of 800 X 800 and the nodes are free to move within this range. The traffic is CBR that is Constant Bit Rate type. The two ray ground model is used for radio propagation to predict [14] the received signal power of each packet. When a packet is received, if its signal power is below the receiving threshold, it is marked as an error and dropped by the MAC layer. An Omni-directional antenna having unity gain is used by mobile nodes.

COMPARISON

Different observations have been made by varying the simulation time and by varying time to live of the packets sent on various simulation times.

- **Simulation Time Taken (In Sec):** 10, 50 & 100

- **Time to Live Taken (In Sec):** 0.05 & 1.5

The graphs of all the comparisons made so far are as follows:

- **AODV SIMULATION**
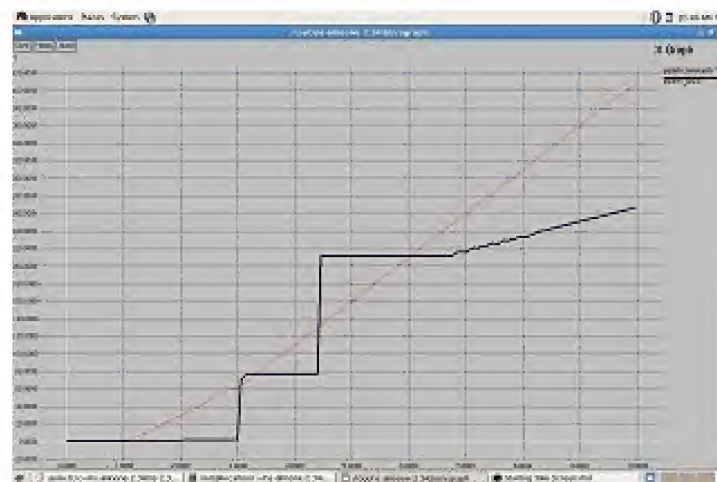
Figure 2: AODV Simulation for 10s and 0.05s TTL
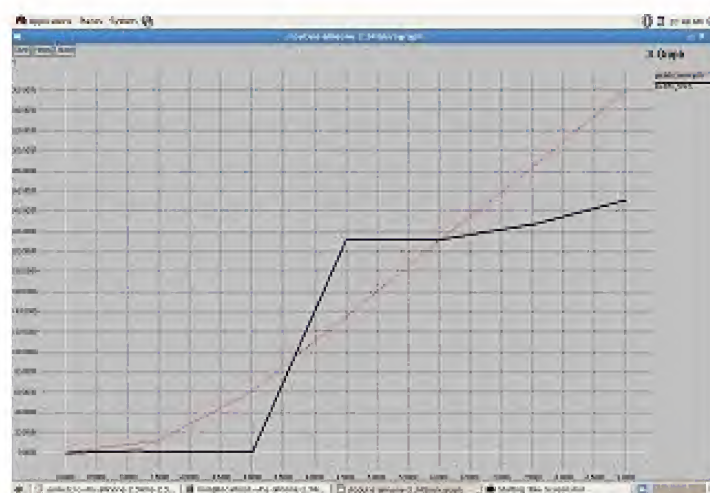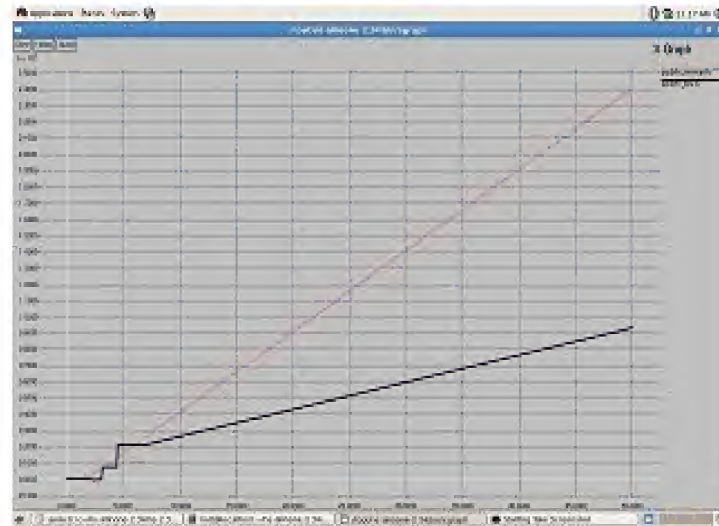

Figure 3: AODV Simulation for 10s and 1.5s TTL

Figure 4: AODV Simulation for 50s and 0.05s TTL
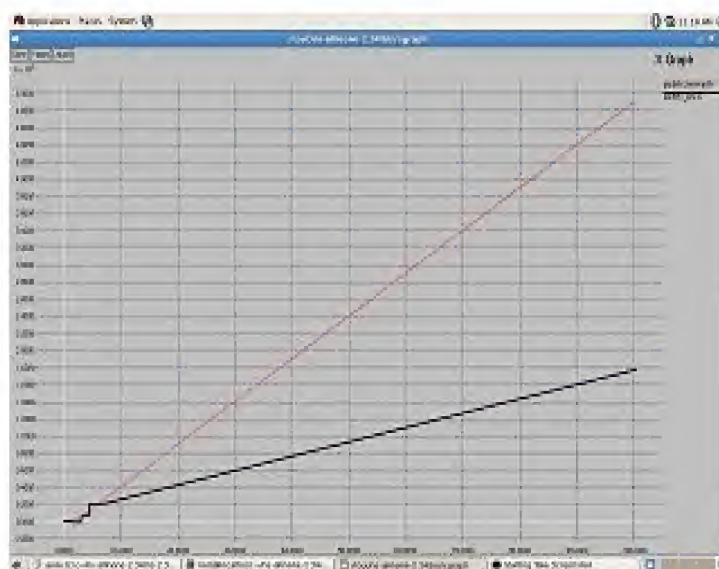

Figure 5: AODV Simulation for 50s and 1.5s TTL

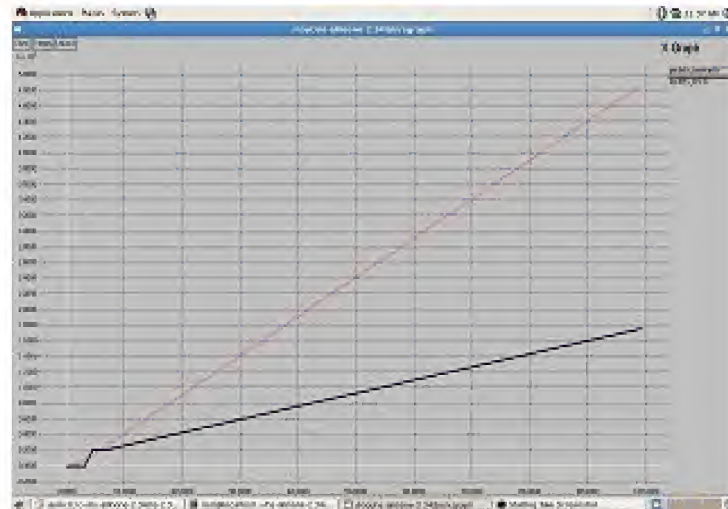**Figure 6: AODV Simulation for 100s and 0.05s TTL**

Figure 7: AODV Simulation for 100s and 1.5s TTL
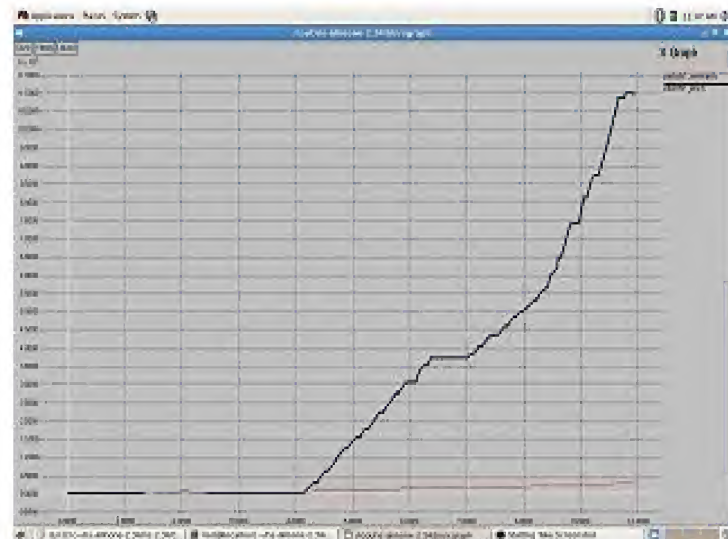
DSR SIMULATION

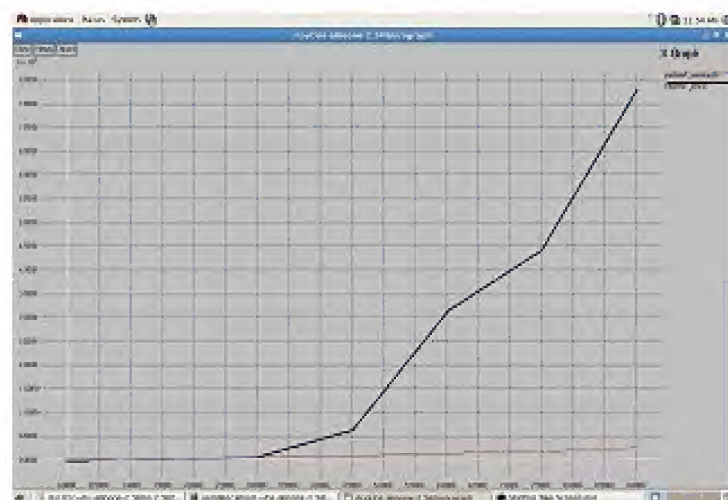**Figure 8: DSR Simulation for 10s and 0.05s TTL**

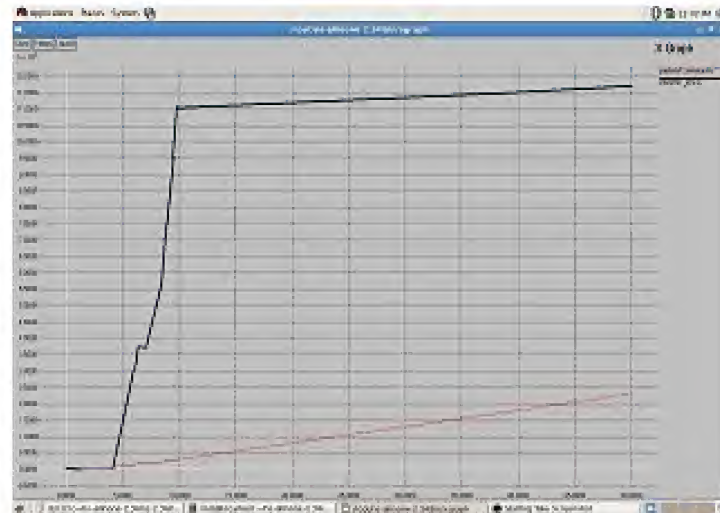**Figure 9: DSR Simulation for 10s and 1.5s TTL**

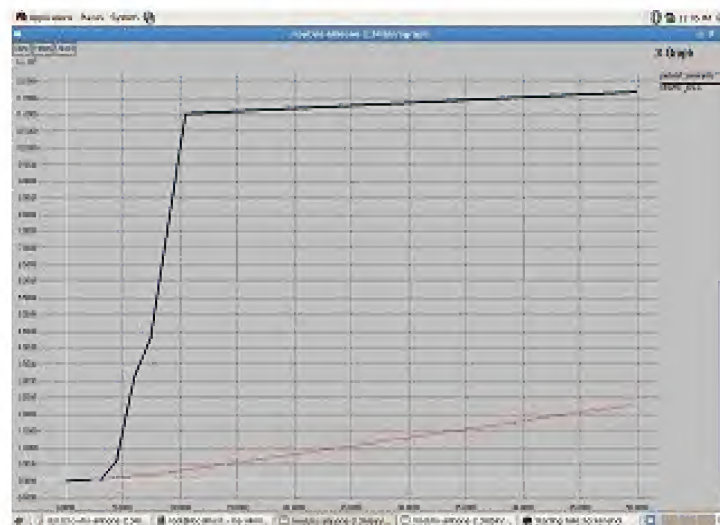**Figure 10: DSR Simulation for 50s and 0.05s TTL**

Figure 11: DSR Simulation for 50s and 1.5s TTL
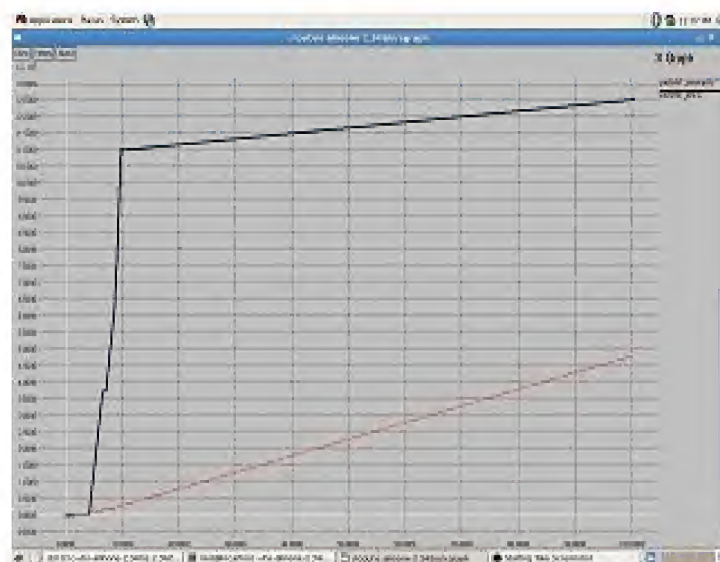

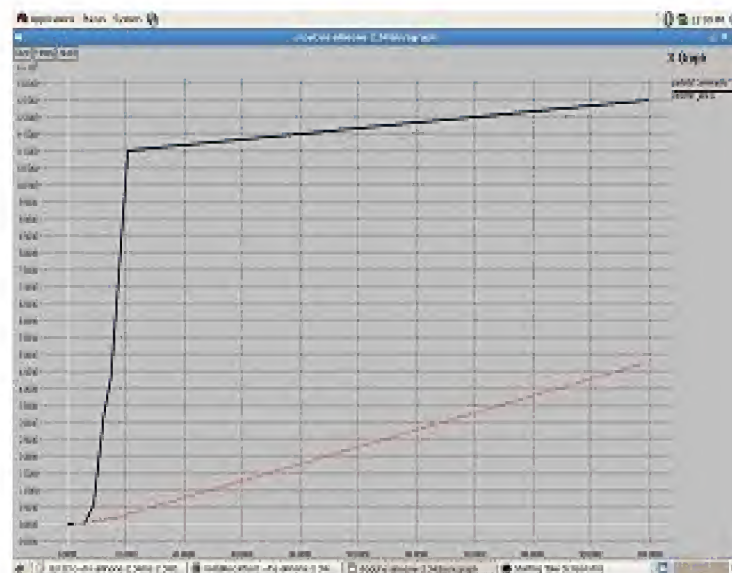**Figure 12: DSR Simulation for 100s and 0.05s TTL**

Figure 13: DSR Simulation for 100s and 1.5s TTL

[The red/faint line represents packet delivery ratio and black line packet loss ratio.]

SIMULATION RESULTS

- **Simulation Time:** With the increase in simulation time for both the protocols, it is observed that since the packet delivery ratio increases with simulation time and number of packets we can say that the performance of both the protocols improves.

- **Packet Delivery Ratio:** When the simulation time is increased for both the protocols the packet delivery ratio that is, the number of packets reaching the destination in a specified amount of time, also increases.

- **Time-To-Live:** The effect of increase of time-to-live of a packet in both the protocols is different. In AODV, the performance of protocol increases whereas, in DSR, with the increase in TTL, not only the packet delivery ratio increases but also there is a slight increase in the packet loss ratio.

CONCLUSIONS

In this paper, an attempt has been made in comparing the two most commonly used demand driven protocols: AODV and DSR, using the tool, Network Simulator. From all of the observations, it can be concluded that AODV performs much better than DSR in packet delivery parameter as its packet delivery ratio is quite higher than that of DSR. Also it is seen that when we increase the simulation time and time-to-live of a packet, for both of the protocols, its packet delivery ratio increases leading to an increase in its performance.

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